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OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

April 9 - April 15, 1999

Summary 99-15

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Table of Contents

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EVENTS

1. ENERGIZED HEATER CABLE CUT

On April 8, 1999, an electrician at the Savannah River K-Reactor Facility cut through an energized 110-V ac heater supply cable inside a motor control center (MCC). Construction electricians were determinating several electrical cables under an approved lockout to prepare the MCC for relocation. The electrician observed an arc, stopped work immediately, and notified his supervisor, who stopped all work on the MCC. Workers taped the wire end to make it safe and barricaded the area. Although the occurrence did not cause a shock or personal injury, the unexpected energy source significantly reduced the margin of safety. (ORPS Report SR--WSRC-REACL-1999-0016)

Investigators for this occurrence determined the following.

- The cable supplied a panel heater, the purpose of which is to maintain low humidity inside the MCC. The heater is located in the bottom of the MCC and is obscured by other equipment.

- The heater is not shown on the standard wiring diagram for the MCC that procedure writers had used to develop the lockout procedure. After the occurrence, personnel were able to locate a building layout drawing that showed the heater in outline but did not show its power source. Procedure writers would not normally use this type of drawing to develop an electrical lockout. Workers physically traced the power for the heater to a lighting panel in the same building and added the supply breaker to the lockout procedure.

- Facility personnel had completed all required steps of the lockout procedure. However, neither the procedure writer nor the job supervisor noticed the heater during their walk-downs.

- Before cutting any cables, electricians had conducted zero-energy checks at the termination points of all cables they believed to be in a particular bundle. However, the heater supply cable was buried in the center of the bundle and its exit point from the bundle also was obscured.

Facility personnel have developed the following corrective actions for this occurrence.

- Inspect all instrument and electrical panels for the presence of panel heaters; identify panel heater power sources and post warnings on affected panels.

- In addition to normal pre-work zero-energy checks, conduct voltage tests on individual cables just before cutting them.

- Develop and issue a site lessons learned bulletin warning of the potential hazards associated with panel heaters.

Personnel who plan or perform work on electrical enclosures should be aware that enclosures frequently contain normally energized panel heaters for controlling humidity. These heaters may be energized from unique sources and may not be shown on standard wiring diagrams, particularly for older equipment. The most common supply voltages for panel heaters are 110 and 220 V ac. Facility managers and work planners should consider adopting the corrective actions taken at Savannah River to minimize the hazard presented by panel heaters.

KEYWORDS: construction, electrical safety, energized equipment

FUNCTIONAL AREAS: Construction, Electrical Maintenance, Industrial Safety

2. EXPLOSION DURING LITHIUM RECOVERY OPERATIONS AT OAK RIDGE

On March 31, 1999, at the Oak Ridge Y-12 Site, an explosion occurred when a chemical operator performing lithium hydride recovery operations submerged a high-efficiency particulate air (HEPA) filter embedded with lithium hydride residue into a 75-gallon salvage vat containing demineralized water. Lithium hydride reacts exothermically with water to form caustic lithium hydroxide and flammable hydrogen gas. After submerging the filter, the chemical operator left the area to continue other work assignments. Approximately 25 minutes later, operations personnel heard an explosion, responded to the location of the cleaning vat, and secured the area. The force of the explosion blew the filter apart, expelled approximately 1 quart of caustic solution from the vat, and knocked the Lexan™ door that covered the front part of the vat onto the floor. Several small pieces of smoldering lithium residue and filter material were also expelled from the vat. No personnel were in the immediate area around the vat when the explosion occurred, and there were no injuries. (ORPS Report ORO--LMES-Y12NUCLEAR-1999-0031)

The HEPA filter being cleaned was part of a vacuum system located in a glovebox used to fill molds. The filter is a densely packed, pleated, aluminum and paper cubic matrix, 12 in. by 12 in. by 6 in., with a nailed and glued plywood frame. The hydrogen gas produced by the lithium hydride and water reaction is vented from the vat through a hood that exhausts to the outside atmosphere. The water solution becomes caustic as lithium hydroxide is formed, and the HEPA filters are discarded when the reaction is complete. The lithium hydroxide solution is then processed to recover the lithium.

Investigators determined that the HEPA filters are not monitored for lithium hydride loading, and although the operator said it looked no different than other filters cleaned that day, investigators believe that this particular filter may have been more heavily loaded with lithium hydride residue than expected. The exothermic lithium hydride to lithium hydroxide reaction produced enough heat to begin burning the filter's wood framing, even though the filter was submerged. Investigators believe that oxygen from air trapped in the filter combined with the hydrogen generated from the reaction, causing the explosion. Investigators also determined that it had once been a skill-of-the-craft practice to perforate a filter with holes before cleaning to more efficiently liberate entrapped air and hydrogen during the reaction. This past practice had been lost over time owing to the attrition of experienced operators and had not been captured in the procedure for cleaning the filters.

Since the occurrence, lithium salvage operations have been suspended, incident critiques performed, and a job hazard analysis developed for cleaning up the area and removing the filter from the salvage vat. A causal analysis is being performed to ensure all corrective actions are captured, and a hazard analysis is being conducted on all salvage operations. In addition, other lithium operations are being evaluated to determine if they warrant a hazard evaluation, and training and procedures are being reviewed to determine if skill-of-the-craft knowledge is adequately captured. The maintenance packages and procedures used for replacing, handling, storing, and cleaning filters contaminated with lithium are under review for adequate hazard analysis and safety precautions. In the interim, salvage and filter-changing operations have been suspended until corrective actions are fully identified and completed.

NFS has reported other events in the Weekly Summary that involve improper handling and storage of lithium and lithium compounds. Some examples follow.

- Weekly Summary 98-09 reported that chemists at the Idaho National Engineering and Environmental Laboratory found five sealed containers of lithium metal stored inside a nitrogen glovebox instead of an adjacent argon-inerted glovebox. Lithium can react with nitrogen to produce a highly exothermic reaction. The chemists immediately transferred the containers of lithium to the argon-inerted glovebox. (ORPS Report ID--LITC-ERATOWNFAC-1998-0001)

- Weekly Summary 97-04 reported that Special Materials Organization personnel at the Oak Ridge Y-12 Site discovered two containers in which lithium metal was not submerged in mineral oil or inerted. Operators repackaged the metal in mineral oil and verified that the remainder of the inventory was properly stored. (ORPS Report ORO--LMES-Y12SITE-1997-0003)

- Weekly Summaries 95-24 and 92-36 reported fires caused by the pyrophoric reaction of lithium and water at the Lawrence Berkeley Laboratory. (ORPS Reports SAN--LBL-EED-1995-0001, SAN--LBL-EHS-1992-0012)

OEAF engineers also reviewed another lithium explosion incident at the Y-12 Site in August 1997. Two Special Materials Organization workers were conducting reactor lid washing activities when an explosion occurred. The reactor lid is one component of a reaction vessel for hydriding lithium metal. The workers were preparing to cleanse the accumulation of reaction by-products from the interior surface of the lid and had placed the lid on a washing station. As they began a nitrogen purge before actual washing activities, the workers heard the explosion and saw a burst of flames from the reactor lid and washing station. They also observed material inside the washing station ignite and burn and saw smoke. Neither worker was injured, but both were initially stunned by the loud noise of the explosion. Investigators determined that lithium metal splatters on the interior surface of the reactor lid, deposited during the reaction to hydride the lithium, had reacted with moist air blown across the lid at the beginning of the nitrogen purge process. The reactor lids are washed with steam, and the nitrogen and steam were introduced to the wash station through a common set of spray nozzles. Residual moisture could not drain from the lines and was blown out when the nitrogen purge was begun. (ORPS Report ORO--LMES-Y12SITE-1997-0034)

These events underscore the importance of safe handling and use of pyrophoric materials. Lithium is one of a number of pyrophoric metals used at DOE facilities. It requires special handling because when it reacts with the nitrogen and water present in air, sufficient heat is generated to cause autoignition and it will burn at temperatures in excess of 1,000 degrees centigrade. Once ignited, lithium either burns itself out or is extinguished only by the very careful application of a smothering agent such as dry sand or powdered sodium chloride, graphite, or copper. Lithium should be stored in argon- or helium-inerted atmospheres. When stored on workbenches, it should be placed in kerosene or in a closed container of mineral oil. Managers of facilities that store lithium metal should refer to the following documents for guidance on the special requirements for safe lithium handling and storage.

- DOE HDBK-1081-94, *Primer on Spontaneous Heating and Pyrophoricity*, contains valuable information on pyrophoric hazards. The section on lithium storage and handling warns that because lithium reacts with water, special precautions are needed to keep it from coming into contact with moisture. Sprinkler protection is undesirable, and combustible materials should not be stored in the same area as lithium.

- DOE/EH-0396P, *Chemical Safety Vulnerability Working Group Report*, and DOE/EH-0398P, *Chemical Safety Vulnerability Management Response Plan*, address the development and implementation of management systems and other administrative controls that can significantly reduce overall hazardous chemical inventories. These documents are available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831, (615) 576-8401. They are also available to the public from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161, (703) 487-4650.

- OSHA Regulation 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories*, includes basic rules and procedures as well as training requirements and other information on the safe use and storage of chemicals in the workplace.

- NFPA, *Fire Protection Handbook*, chapter 6-26, "Combustible Metal Extinguishing Agents and Application Techniques," provides guidance on controlling fires involving combustible metals.

The Chemical Safety Vulnerability Working Group Report and Management Response Plan, as well as other chemical safety references, can be found on the DOE Chemical Safety Program home page at http://tis.eh.doe.gov:80/web/chem_safety/.

KEYWORDS: chemical reaction, lithium, pyrophoric

FUNCTIONAL AREA: Materials Handling/Storage

3. RESOLVING CONFLICTS BETWEEN RADIOLOGICAL AND INDUSTRIAL SAFETY REQUIREMENTS

In the past three years, three machinists at three different commercial nuclear stations have suffered serious injuries while wearing anticontamination clothing and working on potentially contaminated lathes. Throughout the DOE complex, similar contaminated machine work is performed daily, and the potential exists for similar injuries to occur. The following three events from the commercial nuclear industry illustrate how the conflict between the requirements of contamination protection and those of machine shop safety during contaminated lathe work can lead to personnel injury.

- On November 21, 1998, a contract machinist was severely injured while cleaning a valve plug on a lathe. The machinist wore anticontamination clothing because the valve stem and lathe were contaminated. A piece of his anticontamination clothing became tangled in the rotating assembly, causing multiple injuries, including a broken arm. To clean the valve plug, the machinist held a 2-foot length of abrasive cloth by the ends, moving it back and forth over the work. His anticontamination clothing became tangled in the work when his arm came too close to the rotating stem. The machinist used his foot to push the drive lever and disengage the lathe from the motor as he was pulled onto the lathe. A helper needed to be told how to stop the lathe motor by the still-conscious machinist.

- On May 17, 1997, a machinist was cleaning a valve stem on a lathe when his rubber gloves and cloth hood became entangled in the lathe. The machinist suffered serious injuries to all his fingers, and to his nose, jaw, and several teeth. Dressed in standard anticontamination clothing, he was palm-sanding the rotating piece of work with an abrasive cloth.

- On April 12, 1996, a contract machinist was hand-sanding a valve stem on a lathe when his rubber gloves became trapped between the sandpaper and the lathe. The machinist's coverall sleeve also became entangled in the lathe, breaking his arm. Hand-sanding while wearing standard rubber gloves contributed to this event.

OEAF engineers reviewed the ORPS database for similar occurrences within DOE. The following events reflect the need for managers and workers to continue to thoroughly evaluate specific activities with respect to worker safety when work is being performed around rotating equipment.

- On January 20, 1999, an employee machinist at the Oak Ridge Y-12 Site detected contamination on his left elbow when he self-monitored while leaving a radiological area. The machinist had been performing routine operations on a contaminated lathe, and he stated that he had inadvertently rubbed his elbow against the contaminated surface of the lathe while setting up material to be machined. Because of the safety concerns associated with rotating equipment, the radiological work permit for this activity required the machinist to wear modified protective clothing with short sleeves. The possibility of an occasional personnel contamination event during machining operations was evaluated and found to be acceptable when compared to the risk of personnel injury associated with the rotating equipment hazard. (ORPS Report ORO--LMES-Y12NUCLEARE-1999-0010)

- On July 14, 1997, a Nevada Tonopah Test Range machinist suffered extensive injuries to his right hand and arm while performing a sanding operation on a lathe. The employee's gloved right hand became entangled in the rotating lathe and the piece he was machining. A portion of his right index finger was severed and he required four days of hospitalization. Although there was no potential for contamination during the machining operation, this event illustrates how clothing entangled in rotating equipment can cause serious injury. (ORPS Report NVOO--SDNL-TTRO-1997-0003)

Contributing to the events in radiological areas were unresolved conflicts between contamination control requirements and machine shop safety rules. Worker safety must be the highest priority. The question of who is responsible for planning how contaminated lathe work will be performed must be addressed on a case-by-case basis. Work plans must be clearly and jointly made by safety, radiation protection, and mechanical maintenance staff and communicated to all three groups.

The LMES Industrial Safety Group at the Oak Ridge Y-12 Site addressed the issue of radiological protection requirements that interfere or conflict with worker safety. In 1995, employees raised a number of concerns about the job hazards being created by new requirements for radiation worker protective clothing. Among these concerns were (1) slip hazards from rubber overshoes, (2) entanglement in rotating equipment, (3) heat stress, and (4) various forms of obstructed vision as a result of wearing hoods. Based on these concerns, an evaluation team comprised of industrial safety, industrial hygiene, and radiation protection personnel was formed. The team reviewed regulatory and plant standards, interviewed affected employees, walked down work areas requiring radiological control, and tested imposed clothing requirements in actual work situations. Three primary corrective actions that address most of the conflicts were identified.

- Job hazards are accurately identified for individual work areas and are not addressed generically. In many cases, a perceived safety hazard or contamination issue is not credible for a particular work area. Addressing work area hazards generically caused excessive implementation of protective measures, which in turn created more hazards.

- When work situations are being analyzed, the need to wear properly fitted protective clothing should be considered. Improperly fitted hoods or shoe covers can contribute to slips or obstructed vision. When properly fitted clothing is prescribed, the hazard is eliminated.

- When a conflict remains between controls for an industrial hazard and a radiological hazard, the Y-12 Site utilizes the Radiation Work Permit to determine the clothing requirements for a particular work activity. With input from both operations and industrial safety personnel, generic plant standards and procedure requirements can be adapted for a particular work environment.

The common approach of these corrective actions involves a detailed and specific job hazard analysis to eliminate conflicts between radiological and industrial safety requirements. At the Y-12 Site, whenever the potential for radioactive contamination is more acceptable than the consequences of injury, protective clothing requirements are substantially reduced or eliminated altogether.

Current efforts to implement the Integrated Safety Management System throughout DOE will significantly encourage the hazard analysis and team evaluation processes required for worker safety in each work situation. At the Y-12 Site, the lessons learned from these evaluations were incorporated into plant procedures and distributed as required reading to the workforce. Information about the hazards associated with the use of personal protective equipment (PPE) is contained in the following documents.

- DOE O 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, attachment 2, “Contractors Requirements Document,” requires contractors to identify existing and potential workplace hazards and evaluate the risk of associated worker injury or illness. The attachment also requires contractors to implement a hazard prevention/abatement process to manage all identified hazards. Hazard control methods are hierarchized as (1) engineering controls, (2) work practices and administrative controls, and (3) personal protective equipment.

- DOE G 440.1-1, *Worker Protection Management for DOE Federal and Contractor Employees Guide*, provides guidance on hazard identification, evaluation, prevention, and control. Section 4.4.4.3, “Personal Protective Equipment”, states that the use of PPE can itself create significant worker hazards. It identifies the two basic objectives of any PPE practice: (1) protecting the wearer from safety and health hazards and (2) preventing injury to the wearer from incorrect use and/or malfunction of the PPE.

- 29 CFR 1910, subpart I, Appendix B, “Non-Mandatory Compliance Guidelines for Hazard Assessment and Personal Protective Equipment Selection,” helps employers and employees to comply with the requirements of 1910.132(d) for a hazard assessment when selecting personal protective equipment.

Radiological protection, industrial safety, and maintenance professionals should review their programs and work together to ensure that worker safety is not compromised by unnecessary, generic, or conflicting requirements. Further information regarding the resolution of radiological and industrial safety conflicts and details concerning the evaluation of particular hazards are available from Mark McKinney, LMES Industrial Safety Program Technical Lead, at (423) 574-1568.

KEYWORDS: anti-c clothing, good practices, industrial safety, job-hazard analysis, personnel safety, rotating equipment, safety hazard

FUNCTIONAL AREAS: Industrial Safety

4. DIESEL FUEL TANK DAMAGED BY OVERPRESSURIZATION

On April 12, 1999, the health and safety manager for the Grand Junction Projects Office Monticello Project reported that a 1,000-gallon diesel fuel tank had suffered structural damage when it was overpressurized during refueling. Because the fuel tank did not have adequate venting capacity, pressure built up, deforming the tank and launching the fuel nozzle approximately 15 feet into the air. As a result, 10 gallons of diesel fuel spilled, most of which remained inside a berm for spill containment. The fuel vendor had supplied the diesel fuel tank and a 2,000-gallon gasoline tank to support Monticello project subcontractor operations. Improperly vented tanks can result in tank failure, release of tank contents, and personnel injury. (ORPS Report ALO--MCTC-GJPOTAR-1999-0001)

On March 23, 1999, an employee of a local fuel vendor arrived at the Monticello, Utah, project site to refuel the gasoline tank and the diesel fuel tank. After refueling of the diesel tank had gone on for about 10 minutes, a buildup of pressure within the tank caused the nozzle to eject from the refueling port, spilling diesel fuel. No personnel were injured in this event. The subcontractor immediately suspended all refueling operations. Because the tank sustained structural damage, the vendor was directed to pump out the remaining fuel to eliminate the possibility of a spill if the tank ruptures. Personnel promptly initiated cleanup activities. The subcontractor directed the fuel vendor to remove the damaged tank from the site.

DOE and contractor project managers initiated an investigation. Investigators determined that the fuel tank was configured with an electric fuel pump that used a port at the top of the tank rather than the bottom. This left only the refueling port as a vent path. During fueling, the filler nozzle restricts the opening that is used for a vent. This violates OSHA Standard 29 CFR 1926.152, *Flammable and Combustible Liquids*, section (i)(2)(iv), "Normal Venting for Aboveground Tanks." The standard states that low-pressure tanks and pressure vessels shall be adequately vented to prevent any pressure or vacuum that develops (as a result of filling or emptying or atmospheric temperature changes) from exceeding the design pressure of the tank or vessel. Protection shall also be provided to keep overpressure from any pump from discharging into the tank or vessel when the pump discharge pressure can exceed the design pressure of the tank or vessel.

Investigators also determined that the pump on the fuel truck could deliver 60 to 70 gpm at 30 to 40 psi. Engineers calculated that the tank could have experienced a pressure increase of between 3.3 and 19.5 psi. The fuel tank inlet opening has a plastic screw-on cap with a flapper-type lid and a polyethylene insert. The lid acts as a vent for the tank while the tank is not being filled. The fuel vendor employee indicated that he had wedged the fill nozzle into this opening to ensure that it remained in place during refueling. Had the tank been equipped with a separate vent or had the employee removed the fill cap/vent (including the polyethylene insert), the tank would have been adequately vented. The employee also indicated that he had not been trained on the subcontractor's refueling plan and that no subcontractor representative was available to observe him, as required. Investigators also determined that there was no electrical bonding capability for fueling operations.

Investigators concluded that the direct cause was inadequate venting during tank filling and that the root cause was a lack of compliance with existing procedures. Contributing causes include (1) a lack of site-specific training on the task to be performed, (2) a lack of supervision by the subcontractor of the vendor employee, as required by the subcontractor's refueling plan, and (3) installation of a submersible pump in the alternate tank opening at the top of the tank. Managers identified several corrective actions. Some of these actions follow.

- The subcontractor will ensure that the fuel tank possesses a vent capacity, as required by 29 CFR 1926.152(i)(2)(iv)(c), and that the vendor's fuel nozzle has a pressure shutoff instead of the existing float shutoff.

- The subcontractor will ensure that fuel vendor employees are trained on the refueling plan and the site health and safety plan.

- The subcontractor will monitor the vendor's fueling operation before and during fueling.

- The subcontractor will ensure that an electrical bonding strap is available for all fueling operations involving more than 5 gallons.

This event illustrates the importance of ensuring that vendor-supplied fuel tanks and equipment are compliant with all applicable federal codes and standards. Also, facility managers should ensure that vendors who come on-site to support this equipment are trained in the applicable site-specific procedures and health and safety plans. Facility personnel should supervise or observe vendor activities while the vendors are on-site to verify the activities are performed safely and in accordance with procedures. Facility personnel should be available to provide immediate assistance if there is an accident or a spill of hazardous material.

KEYWORDS: damaged, diesel fuel, fuel, pressurized, procedure, spill, tank, training and qualification, vent

FUNCTIONAL AREAS: Industrial Safety, Materials Handling/Storage, Training and Qualification

5. UNAUTHORIZED WORK ON ENERGIZED ELECTRICAL CIRCUIT CAUSES LOSS OF POWER

On March 30, 1999, at the Pantex Plant, an electrical contractor caused an electrical arc when a switch he knew was energized accidentally contacted a metal switch box while he was pulling cable. The arc resulted in a loss of power to building systems and equipment. Facility managers had not authorized any energized (hot) work. The power loss affected light circuits, a fire alarm panel, two air-handling units, and two condensate pumps. It took facility personnel approximately 6 hours to totally restore power. The electrical contractor was wearing gloves and safety goggles and using insulated tools while he performed the hot work. There were no injuries or damage to facilities or equipment as a result of this event. Working on or near energized electrical equipment can, however, result in serious injuries or a fatality. (ORPS Report ALO-AO-MHSM-PANTEX-1999-0028)

The electrical contractor was preparing to install a new conduit for a strobe light in an equipment room. The installation required either a new penetration through a cemesto board wall or the use of an existing penetration. The contractor saw an abandoned conduit that penetrated the wall and decided to remove the existing conduit and wiring and reuse the penetration instead of having facility personnel drill a new penetration through the cemesto board wall, which contains asbestos. He noticed the conduit was connected to a light switch box and attempted to locate the source of the electrical feed and lockout. Unable to locate a disconnect switch or circuit breaker, he decided (without facility management approval) to work on the box while it was energized. In order to pull the abandoned wiring from the conduit, he removed the cover plate and attached switches from the switch box. While he was pulling the wiring, one of the switches contacted the metal switch box and arced.

Investigators determined that the electrical contractor could not locate an electrical isolation point for the lockout because there was a configuration control problem. Facility electricians discovered four breaker panels that had misidentified electrical feeds. The electrical contractor discussed his inability to find a lockout point with his supervisor, who allowed him to pull the cables with the switches energized. Investigators also determined that the electrical contractor did not adequately insulate the switches to prevent an arc or short circuit if they came in contact with the metal switch box.

NFS has reported other events in the Weekly Summary that involved working on or around energized equipment. Some examples follow.

- Weekly Summary 99-08 reported that a maintenance electrician at Sandia National Laboratory—New Mexico caused a short circuit and received electrical flash burns to his left hand and a finger on his right hand while troubleshooting an energized 120/208-V ac power strip. In addition, flying hot metal particles from the short circuit caused a fire in a nearby stack of paper. The electrician was testing the voltage on a power strip to isolate and determine the cause of an intermittent loss of power when his voltmeter test leads contacted two-phase connector contacts, causing the phase-to-phase short circuit. He was not wearing safety glasses or gloves. Investigators determined that the electrician had used a generic work order that did not require him to lock out or tag out the power strip. (ORPS Report ALO-KO-SNL-NMFAC-1999-0002)

- Weekly Summary 98-16 reported that a wireman at the Nevada Test Site was replacing a 110-V breaker inside an energized 480-V panel without a lockout/tagout or personal protective equipment. Investigators determined that facility procedures for energized work required using insulated gloves and tools and following the "two-man rule." They also determined that site procedures did not permit work on energized systems unless a facility manager or a qualified supervisor approved it. (ORPS Report NVOO--LANV-NTS3-1998-0001)

- Weekly Summary 96-51 reported that a technician at Sandia National Laboratory received an electrical shock and a pinpoint-size wound when his right hand came close to a bank of capacitors with a 4,200-V potential. Investigators determined he was not wearing the protective equipment required for work on energized high-voltage systems. (ORPS Report ALO-KO-SNL-14000-1996-0004)

These events illustrate the importance of obtaining proper authorization before working on energized equipment that cannot be de-energized to support the work activity. Except for cases where testing or troubleshooting requires the equipment to be energized, removing the energy and controlling the source of the energy with a lockout/tagout is the best practice. Also, electrical circuit breakers and switches must be properly labeled to show which electrical circuits and equipment they energize, so that the correct circuit or equipment can be isolated. Work involving potentially energized equipment should be thoroughly planned and a hazard analysis should be performed.

Facility managers, work planners, and crafts personnel should review the following references, which provide guidance and good practices for planning electrical work.

- 29 CFR 1910.333, *Selection and Use of Work Practices*, states: "Safety-related work practices shall be employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits which are or may be energized." It also requires a qualified person to test the equipment to verify that all circuit elements and equipment parts are de-energized.

- 29 CFR 1910, *Occupational Safety and Health Standards*, and DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities,* provide guidance on the implementation of effective lockout/tagout programs. They both state that the primary purpose of a lockout/tagout program is to protect personnel from injury and protect equipment from damage. 29 CFR 1910, subpart S, "Electrical," describes work practices to be employed to prevent injuries when work is performed near or on equipment or circuits that are, or may be, energized.

- DOE/ID-10600, *Electrical Safety Guidelines*, prescribes electrical safety standards for DOE field offices and facilities. It includes information on training and qualifications, work practices, protective equipment, insulated tools, and recognition of electrical hazards. Section 2.13.1.3 states that when circuits and equipment are worked on they must be disconnected from all electrical energy sources. These guidelines are intended to protect personnel from electrical shock and potential fatalities.

- DOE-HDBK-1092-98, *Electrical Safety*, contains explanatory material in support of OSHA regulations and nationally recognized electrical-safety-related standards. It addresses electrical safety for enclosed electrical and electronic equipment and discusses the latest editions of 29 CFR 1910 and 29 CFR 1926 and National Fire Protection Association Standard 70E, *National Electrical Code*.

KEYWORDS: configuration control, electrical short, energized equipment, labeling, near miss, work control

FUNCTIONAL AREAS: Configuration Control, Electrical Maintenance, Industrial Safety

OEAF FOLLOW-UP ACTIVITY

1. CORRECTION TO WEEKLY SUMMARY 99-14, ARTICLE 5

The article, and the occurrence report on the event, incorrectly stated that the vent tube that broke, allowing chlorine gas to leak, was made from Tygon® tubing. The vent tubing was in fact a plastic pipe made from polyethylene.

KEYWORDS: compressed gas, inspection, preventive maintenance, tubing

FUNCTIONAL AREAS: Industrial Safety, Mechanical Maintenance